

THE SILURIAN TRILOBITES OF NEW SOUTH WALES,
WITH REFERENCES TO THOSE OF OTHER
PARTS OF AUSTRALIA.

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PART III.

The PHACOPIDÆ.

(Plates XXXVIII.-XL.)

The family of the Phacopidæ is one of the most important to be met with in our Lower Palæozoic rocks, both on account of the wide distribution of its members geographically—being met with in the Silurian rocks of both N.S. Wales, Victoria, and Tasmania—and their close connection with those of similar deposits in the Old World.

The literature of the family is very limited, and is confined to the description by Sir F. McCoy of species referred* by him to the following:—

1. *Odontochile caudatus*, Brün., sp.
2. *Portlockia fecundus*, Barr., sp.

and by Mr. A. F. Foerste† to—

3. *Phacops serratus*, Foerste.

The horizons yielding these fossils are:—

- a. Olive mudstones of Broadhurst's Creek, near Kilmore, Victoria—No. 1.
- b. Arenaceous beds of Yerring, Upper Yarra, Victoria—No. 2.
- c. Olive-brown mudstones of the Bowning District, N.S. Wales—No. 3.

* Prod. Pal. Vict. 1876, Dec. iii. pp. 13-16.

† Bull. Sci. Lab. Denison Univ. 1888, iii.

We do not notice incidental references to other localities, when unaccompanied by descriptions, nor catalogue names in the same category.

The Tasmanian forms are at present undescribed.

The Phacopidæ is represented throughout Australian Silurian rocks, so far as we can ascertain with certainty, by two genera only—*Phacops*, Emmrich, and *Hausmannia*, Hall and Clarke. During our researches we have not met with any Trilobites that could be referred to either of the following :—*Acaste*, Goldfuss; *Chasmops*, McCoy; *Pterygometopus*, Schmidt; *Trimerocephalus*, McCoy; *Portlockia*, McCoy; *Cryphæus*, Green; *Coronura*, Hall and Clarke; *Odontocephalus*, Hall and Clarke; or *Corycephalus*, Hall and Clarke.

We imply a doubt because the subject of our Pl. xxxix. fig. 12, appears to foreshadow a third section or genus, but the material is too scanty to enable us to pass a definite opinion.

Genus PHACOPS, Emmrich, 1839.

Phacops in its restricted sense, following the researches of Salter* and Schmidt,† and to some extent of Barrande‡ also, omitting other minor characters, is distinguished from other members of the Phacopidæ chiefly by the presence of the two anterior pairs of glabella furrows, generally linear in character, and of which the first or anterior pair frequently consists of two branches. The fore part of the glabella, formed by the frontal and lateral lobes, is, as a whole, cut off from the neck segment by the intervention of a supplementary ring, termed by Barrande the “intercalary ring” (anneau intercalaire)§. Barrande used this feature as one of the chief distinguishing points between the only two genera recognised by him in the Bohemian Silurian rocks, *Phacops* and *Dalmania* (vel *Dalmanites*). This eminent author considered

* Mon. Brit. Sil. Trilobites, Pt. 1, pp. 13 and 14.

† Mém. Soc. Imp. Sci. St. Petersb. 1881, xxx. (7), No. 1.

‡ Syst. Sil. Bohême, 1852, i. p. 498.

§ Loc. cit. p. 505.

that *Phacops* possessed the three ordinary pairs of glabella furrows, whilst Salter viewed the first pair as consisting of two parts, a feature in which Schmidt seems to agree with him, i.e., Salter's first pair is equal to Barrande's first and second. The arguments for and against the respective views of these authors are too long to be introduced here, but looking at the matter dispassionately there appear to be good grounds for supporting the opinions of Salter and Schmidt.

The presence of the intercalary ring we regard as of very considerable importance in the limitation of *Phacops* proper. It is the "linear lobe" of Salter,* and the groove separating the ring from the glabella proper is the "maxillary furrow" of McCoy†. The intercalary ring is, in fact, formed by the confluence of the third pair of glabella furrows, with small circumscribed lobes at the outer ends. It appears to mark off a series of species, including *Phacops latifrons*, Bronn, the type of the genus, *P. cephalotes*, Corda, *P. fecundus*, Barr., and some others, from the remaining sections, sub-genera, or genera, whichever the reader prefers to regard them, usually associated under the broader name of *Phacops* of older writers. We therefore adopt *Phacops* as limited and defined more especially by Salter, and followed in many particulars by Schmidt. This restriction also has the advantage of comprising within it Emmrich's type of his genus, *P. latifrons*, Bronn.

As regards species, we have succeeded in establishing the presence of three in the Silurian rocks of N.S. Wales, viz.:—

Phacops Crossleii, nobis.

„ *latigenalis*, nobis.

„ *serratus*, Foerste.

And two in Victoria, viz.:—

Phacops Sweeti, nobis. (? *P. fecundus* McCoy, non Barr.)

„ *mansfieldensis*, nobis.

If, however, *P. fecundus*, McCoy, be distinct from our *P. Sweeti*, then three forms are known from Victoria.

* Mon. Brit. Sil. Trilobites, Pt. 1, p. 21.

† Prod. Pal. Vict. 1876, Dec. iii. p. 15.

PHACOPS CROSSLEII, *sp. nov.*

(Pl. XXXIX., figs. 9-11.)

Sp. Char.—*Body*—oblong-oval. *Head-shield or cephalon*—Semi-circular, rather flattened above, sides abruptly depressed; glabella large, subpentagonal, greatly contracted behind, highest between the eyes, very slightly arched in front, overhanging the front border, rounded so that taking for centre the middle point of the confluent basal pair of glabella furrows, the curve forms the arc of a circle with radius equal to the length between the point mentioned and its front, tolerably inflated, sides straight, inclined inwards at an angle of 60° , greatest width equal to length including neck ring, coarsely granulate; intercalary furrows distinct, deep (in casts) at sides and close to the neck furrow, with which they communicate, thus forming prominent basal lobes; second pair linear, feeble and falcate, and seem, in some specimens, to communicate with the basal pair, and with the axial grooves; first or frontal pair linear, faint and feeble, arising from the axial furrow at the front corners of the glabella, and traversing it in a very widely V-shaped manner, the inner portion being shortest and slightly falcate; frontal lobes very large, second pair cleaver-shaped, third pair suboblong, fourth pair nodular; neck furrow very distinct, continued across the side lobes with equal distinctness; and faintly along the inner edge of the border of the free cheeks to the front of the axial groove; neck ring robust, strongly arched, granulate, one large granule in the middle line; axial grooves very distinct, deep and wide; fixed cheeks small; genal lobes* moderately arched, granulate and separated from the palpebral lobes by distinct shallow furrows, which pass posteriorly round and under the eyes, giving relief to those organs. Eyes large, equal in length to half of the longitudinal length of the cheek, anteriorly scarcely reach the front

* That portion of the fixed cheek between the palpebral lobe and axial furrow and bounded posteriorly by the lateral extension of the neck furrow.

angles of the glabella, posteriorly in a line with the basal glabella furrows; curve of lentiferous face front to back semicordoid, apically inclined inward at an angle of about 50° ; lenses very convex, the normal number of vertical rows is seventeen, with five lenses in each, except the terminal rows at each end; the first row in front has usually three, the next four, then follow twelve rows of five lenses, their three posterior rows having four, three and two respectively, making a total of seventy-six lenses for each eye, which are separated by minute spaces, but no partitions are visible.

Thorax.—Square, sides almost perpendicular; axis distinct, sub-semicylindrical, about two-thirds as wide as the contour measurement of the pleuræ, ends of each segment nodular, posterior segments distinctly arched forward; pleuræ between axial furrow and fulcræ horizontal, then intensely deflected, forming almost perpendicular sides, extremities procurved and flattened; pleural furrows distinct on horizontal portions, gradually diminishing on the deflected parts and ceasing about midway between the fulcræ and extremities, making the front ridges distinctly triangular, posterior ridges very robust and continuous, with diminishing intensity to the rounded extremities, posterior edges of pleuræ traversed (in decorticated specimens) by a fine groove which shows most distinctly on the deflected portions, evidently marking the thickness of the test.

Pygidium.—Roughly semicircular, highly convex, anterior margin nearly straight; axis very prominent, composed of eight segments, the first and second segments very distinct, and strongly arched forward; each succeeding segment diminishes in distinctness so that the blunt terminal piece is hardly separable from the thickened border, and is half the width of the anterior portion; axial furrows moderately distinct; lateral lobes very tumid, sharply deflected, consisting of six or seven pleuræ, furrows of first pair like those of the thoracic pleuræ, each succeeding pair becoming fainter till the seventh is rarely discernible and do not reach the edges; sutures distinct; in decorticated specimens a distinct

smooth border is exposed bounded on outer edge by a linear furrow.

Obs.—This species in some respects resembles *P. fecundus*, Barr., with which we were inclined on first inspection to consider it to be identical. Closer examination, however, has revealed sufficient differences between them to justify us in separating it from that species.

In the first place, in our species the greatest length of the glabella, including the neck ring, equals its greatest width. In *P. fecundus* the glabella furrows are distinct on immature individuals, but rarely so on mature ones, which is just the opposite to the case in our species. Again, the eyes of the latter have, so far as we have been able to observe in all our numerous specimens, a constant number of seventeen vertical rows of lenses, and never more than five lenses in a row, except in rare cases where a rudimentary lens occurs at the top.

The lateral extension of the neck furrow around the edge of the border of the side lobes is not nearly so distinct in our species as in *P. fecundus*, Barr., and it ceases in front of the eye instead of joining the furrow passing round the frontal base of the glabella.

Between the thoraces of the two species there appears little difference, except that the thoracic test of ours seems to have been smoother, and the sides more perpendicular.

The pygidium of our species is more nearly semicircular, and its axis is not sunk between the side lobes, with an almost constant number of seven segments, and rarely if ever eight. The side lobes are divided into six or, doubtfully, seven pleuræ.

To sum up, our species is separated from *P. fecundus* by having a much smaller eye, the features of which remain constant in all mature individuals, a less distinct furrow separating the glabella in front from the rudimentary limb, by a smaller number of divisions in the axis and side lobes of the pygidium; and apparently a much thinner test, which was less distinctly granulated on the thorax and pygidium.

P. Crossleii agrees very closely with *P. rana*, Hall, from which it differs in the number of lenses in, and position of the eye; and the absence in the latter of lateral furrows on the glabella.

From our *P. latigenalis* it is separated by the greater proportional length and height of the eyes, and by the constant linear character of the glabella furrows, by the smaller space between the bottom of the eye and the cheek border, the more upright glabella cheeks, and wider axial furrows between the glabella and fixed cheeks. The glabella is also less expanded in front transversely. The pygidium has a more semicircular contour, and its axis differs from *P. latigenalis* by contracting more gradually from front to back, and in not being sunk between the side lobes. The head shields of young specimens of the two species do not show the differences in so marked a manner, nor are the thoraces of the two separable from each other in a decorticated state; but when the mature specimens of each species are compared the differences noted above are evident.

Such a variation may be expected even were *P. latigenalis* the progenitor of this species, for they are separated by 3000 ft. to 4000 ft. of strata, chiefly consisting of mudstone shales, which must represent a long geological period.

From *P. fecundus*, McCoy, it is at once separated by the very much smaller eye, greater posterior contraction of the glabella, deeper and wider axial furrows of the cephalon, and by some differences in the pygidium. *P. Crossleii* is a smaller species than either of the others described in the present paper, or *P. fecundus*, Barr., none of our specimens exceeding two inches in length.

It has been specifically named after Mr. R. Crossley, of Whitefield, Bowning, in recognition of much valuable assistance rendered by him to one of us in the collection of specimens.

Loc. and Horizon.—Bowing Village, Co. Harden. Upper Trilobite Bed, Bowning Series (= *Hume Beds*, Jenkins, and *Nass Beds*, David)—? Wenlock. *Coll.* Mitchell.

PHACOPS LATIGENALIS, *sp. nov.*

(Pl. xxxix., figs. 3-6; Pl. xl., figs. 2-6 and 9.)

Sp. Char.—*Body*.—Oblong ovate. *Head-shield or cephalon*.—Subsemicircular, but a little wider than twice the length. Glabella, including neck ring, wider than long, the proportion being about as 4-3, highly tumid in large specimens, expanded transversely, slightly overhanging in front, and separated from the rudimentary limb by a fairly distinct groove which communicates with the axial furrows, strongly granulate, granules subconical, and nearly uniform in size, sometimes coalescing and forming ridges or wrinkles; glabella grooves very distinct, deep, and in large specimens the first and second pair are overhung by frontal and second lobes very decidedly, intercalary groove wide; second pair gently curved or falcate, and in mature decorticated specimens seem to communicate with the axial furrows; first pair widely V-shaped, the inner branch being subfalcate, passing into the axial furrows at the front angles of the glabella; frontal lobes very large, occupying more than two-thirds of the glabella; second pair small, subdeltiform; third pair small and suboblong; intercalary ring nodular; axial grooves deep; neck furrow very deep and continuing with equal distinctness across the side lobes to the inner edges of the borders of the free cheeks and thence faintly to the front of the eye, where it is interrupted by the lobe on which the eye rests; neck ring intensely arched, rather narrow, ends nodular; fixed cheeks small; genal lobes deltiform, arched, granular; palpebral lobes lunate, separated from genal lobes by shallow but distinct furrows, which continue posteriorly round and under the eyes, adding to the prominence of those organs; anteriorly they pass into the axial grooves; free cheeks practically smooth, coalesced, extended towards the genal angles, border wide, thick, genal angles flattened, forming large triangular facets on which the first pleuræ imbricate. Eyes half as long as greatest length of cheeks, slightly overhanging, subsemicardiod or lunate; perpendicular height small compared with that of most species of the

genus; the number of vertical rows of lenses in each eye is seventeen, and the greatest number of lenses in a row is five, and this number only in a few rows, the other rows having four, three, and two; lenses prominent and not closely packed, cups proportionately small, attachment processes visible, cornea present as partitions between the oblique rows; as far as we have been able to observe, the number of lenses in each eye is 73.

Thorax.—Length about equal to width; axis very prominent and semitubular, width throughout almost the same, and equal to that of the side lobes; fore rings arched forward, outer ends strongly nodular; lateral lobes horizontal between the axial grooves and the fulcra; at fulcra deflected at an angle of 65° - 70° , width of horizontal portion about two-thirds that of the deflected portion; pleural furrows deep, vanishing about midway between fulcra ends in decorticated specimens; pleuræ recurved, facets large and procurved, anterior ridges triangular, posterior ones robust and merging into the facets.

Pygidium.—About twice as wide as long, subtriangular, with a slight transverse central arch; axis conspicuous, slightly depressed between the side lobes, eight rings present; anterior ones intensely arched with a forward inclination, posteriorly diminishing in this respect until the terminal piece almost merges into the border, posterior width a little less than half of the anterior width; six to seven very distinct pleuræ on each side, very convex, steeply depressed at the sides; pleural furrows deep and wide, terminating at the borders; interpleural sutures distinct; axial furrows distinct; the whole surface of the decorticated specimens shows indication of strong granulation.

Obs.—Owing to the great tumidity and rugosity of the glabella, the deep slit-like character of the glabella grooves (overhung in the case of the first pair by the frontal lobes) in the large specimens of this form, we were disposed to make a separate species of this type; but after an inspection of a large number of specimens we conclude that this greater tumidity, &c., results from age.

We have not seen a complete thorax nor the latter with a pygidium attached.

The largest cephalon that has come under observation indicates a length of three and a half to four inches for the whole body, therefore rivalling in size any of the *P. fecundus* or *P. latifrons* groups. From *P. fecundus*, Barr., it is clearly separated by the greater frontal expansion, and tumidity of the glabella, by the very distinct and deep glabella grooves, and the much smaller number of eyelets in the eyes. The presence of the glabella furrows at once separates it from such species as *P. latifrons* and *P. rana*. The above characters also separate it from our *P. Crossleii* and *P. Sweeti*, except that the eyes of *P. latigenalis* and *P. Crossleii* do not differ very widely.

From *P. fecundus*, McCoy, (*non* Barr.), it is also distinguishable by the points above enumerated.

To sum up, the distinguishing features of this species are its very tumid or inflated and rugose glabella, deep overhung glabella furrows, small number of lenses in the vertical rows of the eyes, which are supported on a distinct pedestal, and the wide cheeks.

Loc. and Horizon.—Bowning, and Limestone Creek, near Bowning, Co. Harden. Middle Trilobite Bed, Bowning Series—? Wenlock. *Coll.*—Mitchell; and Geol. and Mining Mus., Dept. of Mines, Sydney.

PHACOPS SERRATUS, *Foerste*:

(Pl. xxxix., figs. 7 and 8; Pl. xl., figs. 7 and 8 and 11.)

P. serratus, Foerste, Bull. Sci. Lab. Denison Univ. 1888. iii.

Sp. Char.—*Body*—Oblongoval. *Head-shield or cephalon*.—Nearly semicircular, a little wider than twice the length, highly tumid. Glabella, including neck ring, as wide as long, overhanging and tumid in front, very convex, surface highly granulate with fairly large and uniform granules, separated from rudimentary limb in front by a very faint groove; sides straight, converging at angle of 60°; frontal furrows linear, widely V-shaped, outer branches straight and passing into the axial grooves at the frontal angles, inner branches subfalcate, medial pair linear, subfalcate, and apparently not joining the axial furrows; frontal lobe large and subpentagonal, second lobes subtrapezoidal, small, third pair suboblong

and small; intercalary ring nodular; axial grooves deep and wide; neck furrow distinct, and continued across the lateral lobes very distinctly; neck ring robust and bearing centrally a spine of varying size, corresponding with the thoracic axial spines, bases nodular; lateral lobes small, triangular, tumid, borders thickened, their measurement from genal angles to the front of the axial grooves equal to half the front width of the glabella; posterior facets strongly ridged; palpebral lobes conspicuous, highly arched, outwardly bounded by distinct narrow borders, granulate; palpebral grooves very distinct, deep at front and back and thus contracting the genal lobes, passing posteriorly round and under the eyes into the lateral extensions of the neck furrow, adding relief to that organ; genal lobes tumid and deltiform; genal angles rounded and faceted; when the thickened borders fall out deep grooves are left. Eyes equal to half the length of cheeks, seventeen rows of lenses, the maximum number in a row being five; cornea and walls of cups thick; lentiferous face, antero-posteriorly, has a semicardiod curve.

Thorax.—As wide as long, very gently contracting posteriorly, sides almost perpendicular, smooth; axis sharply ridged, rings nodular at bases and centrally bearing strong, short recurved spines; when decorticated it is semicylindrical, as wide as side lobes (not measuring the contour of lobes); axial furrows moderately distinct; side lobes horizontal between axial grooves and fulcra, pleuræ slightly recurved, ends rounded in at the posterior angles; medial grooves distinct, reaching beyond the middle of the deflected ends in decorticated specimens, and triangular posterior ridges strong; little or no trace of granulation on any portion of the thorax.

Pygidium.—About semicircular, highly inflated; axis very prominent anteriorly, and terminating indistinctly at the inner edge of the border at about half of its anterior width, slightly depressed between the side lobes, shows eight rings and a terminal piece; the first three rings bear nodules centrally corresponding to the spines of the thoracic axis and are arched forward; each succeeding one becomes less distinct until the last is very

faint; side lobes tumid, seven or eight pleuræ on each; pleural grooves very distinct anteriorly; sutures and axial grooves distinct.

Obs.—This species was described by Foerste from a specimen sent to him by one of us. That specimen was distorted so that the true features of the head were indiscernible, particularly those of the eyes. In fixing the maximum number of lenses in the vertical rows at nine he is in error, for in a number of eyes examined by us the lenses in a row do not exceed five. By fore and aft compression it is not unusual to find an eye with two rows brought into the same vertical line, and in this way appearing to have nine or ten lenses in a vertical row. This is probably the case with Foerste's type specimen.

We are inclined to agree with Foerste in ranking this as a species, for certainly it is very clearly separated from *P. fecundus*, Barr., by the greater inflation of the front of the glabella, the much smaller eye, the less distinct groove passing under the front of the glabella, the absence of granulation on the thorax, thinner test, straighter sides of glabella, greater perpendicularity of the sides of the thorax, greater distinctness of the pleural grooves on the pygidium, smaller size of the animal, and above all the presence of the very conspicuous dorsal spines. This latter feature separates it from all species of the genus known to us.

From *P. Crossleii*, nobis, it is not separable except by the dorsal spines, and it may be that this feature is a sexual one, and the two forms represent the male and female of the one species. In a comparison of a number of heads of the two forms those of *P. serratus*, Foerste, seem to be more tumid in front and to have the glabella more sharply contracted behind by the intercalary groove.

Loc. and Horizon.—Near Railway Station, Bowning, N.S.W. Upper Trilobite Bed, Bowning Series—? Wenlock. *Coll.*—Mitchell.

PHACOPS SWEETI, *sp. nov.*

(Pl. XXXVIII., fig. 9; Pl. XXXIX., figs. 1, 2; Pl. XL., fig. 10.)

[Compare *Phacops (Odontochile) fecundus*, McCoy (? non Barr.), Prod. Pal. Vict. 1876, Dec. iii. p. 15, t. 22, f. 8-9, t. 23, f. 1-6.]

Sp. Char.—*Body*—Oblong oval. *Head-shield or cephalon*.—Subsemicircular, width rather greater than twice its length. Glabella, including the neck ring, about five-sixths of the greatest width, very slightly convex above, slightly subpentagonal, overhanging very little in front, sides straight and steep, limb very rudimentary, and the furrow between it and the glabella faint; three pairs of lateral grooves present, frontal pair passing out at the front angles and running obliquely across the glabella, terminating subfalcately; second pair opposite posterior horns of eyes, both of these pairs are linear; intercalary groove moderately distinct, wide and shallow; intercalary ring with well-marked nodules at each end; the whole glabella surface ornamented with various-sized granules, and wrinkled in front subvertically; neck furrow shallow, moderately distinct, and continued across and round the side lobes, becoming very shallow as it reaches the borders, and continuing so in its frontal extension; neck ring distinct, ends nodular; axial furrows distinct and wide and genal lobes sloping rather steeply into them; lateral lobes subtriangular (equilateral), borders thickened, ridges along posterior faces between the axial furrows and fulcra robust; imbricating facets large; genal lobes highly convex and granulated, separated from the palpebral lobes by a faint furrow* which passes posteriorly around and under the eye, giving relief to that organ, and joining the lateral prolongation of the neck furrow and enclosing between them a suboblong tumose area or extension of the genal lobe. Eyes very large, half as long as postero-anterior length of head, anteriorly almost resting on the cheek borders, being separated from them by the fainter lateral furrows only; normal number of vertical rows of lenses twenty-two, closely packed, tolerably convex, with twelve lenses in each of the central rows, the total number of lenses in each eye being about 220; in the cups the attachment processes visible under a lens; cornea seems to have been thin; lentiferous face curved from front to back lunately,

* This may be termed the palpebral furrow, and should perhaps be considered a generic character.

and sloping upwardly at an angle of 60° to 70° ; height of each eye about two-thirds of its length, in front barely reaching the front angles of the glabella, posteriorly in a line with the central portion of the intercalary furrow.

Thorax.—Of eleven segments, width seems a little greater than length; axis prominent, contracts very gradually posteriorly from the sixth segment, terminating with a width about four-fifths of the anterior width; segments nodular at the ends; lateral lobes very little wider than the axis, horizontal between fulcra and axial furrows, deflected portion steep, component pleuræ imbricate and rounded at the ends; pleural furrows distinct and wide, seeming to reach nearly to the ends; anterior ridges of pleuræ triangular, posterior very narrow; interpleural sutures and axial furrows distinct.

Pygidium.—Subsemicircular or subquadrilateral, width greater than twice the length; axis tolerably prominent, seven segments visible, terminating bluntly with about half the anterior width at the border, slightly sunk between the lateral lobes, which are moderately inflated, horizontal between fulcra and axial grooves, anteriorly deflected to correspond with pleuræ of thorax, but posteriorly becoming less steep; five to six pleuræ visible on each lobe, only the two anterior ones showing the pleural furrows and sutures distinctly, the furrows reach the border, anterior face straight, axial grooves moderately distinct. The whole surface shows evidence of granulation.

Obs.—This species approaches *P. fecundus*, Barr., very closely, but we consider there are sufficient differences between them to justify us in giving specific rank to our form. Its most conspicuous feature is the great size of the eyes, in which respect it surpasses *P. fecundus*, Barr., and many other species of the genus, and as in all the mature specimens that have come under our notice, twenty-two vertical rows of lenses containing twelve in each row are constant features, while in *P. fecundus*, Barr., nineteen vertical rows with nine lenses in a row are the normal features, we consider this to be a sufficient difference for specific



separation. It differs from *P. Crossleii* by the much greater length of its genal lobes, which are conspicuously large. With our *P. latigenalis* it agrees in having a great length of cheek between the posterior angle of the eye and the genal angle.

The glabella of this species appears to have been granulated in the manner common to the genus, but our specimens are all decorticated, and the indications of granulation are observable on the moulds only.

The neck ring of *P. Sweeti* is proportionately wider than either of the N.S. Wales species, which would indicate a wider proportionate axis. That it is quite distinct from *P. Crossleii* and *P. latigenalis* is very clear on (*a*) the greater number of eyelets on each eye and the unvarying character of the eye; (*b*) the perpendicular glabella sides; (*c*) distinctness of the lateral furrows of the glabella on large specimens; and (*d*) the smallness of the basal lobes of the glabella.

We have received a very well-preserved head from Mr. G. Sweet (Pl. xxxix., fig. 2), which he informs us is the usual form of *P. fecundus*, McCoy (!*non* Barr.). We believe it to be identical with the species above described, but still think that it is distinct from *P. fecundus*, Barr. By this specimen we observe that the glabella sides are perpendicular, the nodules of the intercalary ring lie right in the path of the axial furrows, and that the lobes between the intercalary and basal glabella furrows are very small. All these features separate it from the N.S. Wales forms, and the perpendicularity of the sides of the glabella is a feature not possessed by *P. fecundus*, Barr. The whole form of the glabella approaches as near to the quadrate as the pentagonal form.

It is not for us to dogmatise on this point, nor to adversely criticise the work of so accurate an observer as Sir F. McCoy. The above is simply our united opinions based on the material we have been able to accumulate.

Loc. and Horizon.—Mansfield District, Victoria—? Upper Silurian. *Coll.*—G. Sweet, Melbourne.

PHACOPS MANSFIELDENSIS, *sp.nov.*

(Pl. xxxix., fig. 12.)

Sp. char.—*Head-shield or cephalon.*—Twice as wide as long. Glabella subpentagonal, rounded in front, very tumid, intensely contracted behind by the intercalary furrow, sides straight and nearly perpendicular; intercalary furrow distinct and terminating on each side in remarkably deep punctures, intercalary ring prominent and nodular at base; no lateral glabella furrows noticeable; neck furrow distinct, and as it passes into the axial grooves forms very deep punctures or pits, continuing across the lateral lobes with equal distinctness; neck ring highly arched, curving back and nodular; fixed cheeks small, genal lobe prominent, highly arched; palpebral furrow distinct, passing posteriorly round and under the eye; axial grooves wide and deep. Eyes prominent, large, rather longer than half the length of the cheek, separated from the thickened edges of the cheeks by wide or shallow furrows; free cheeks coalesced, margins thickened and straight in front of the eye, giving to the cephalon a triangular character; genal angles terminate in short spines.

Obs.—We have only a decorticated cephalon of this species, which has unfortunately been somewhat contorted and is apparently an immature individual; but the features present clearly separate it from other known Australian forms. Foremost among these features are the genal spines, the great contraction of the glabella by the intercalary furrow, and the very deep punctures on each side of this furrow and of the neck furrow. The genal spines separate it from all described Australian species of this genus. It is further separated from our other Victorian species by having the nodules of the intercalary ring behind the glabella basal lobes instead of in the axial grooves. The great contraction of the glabella by the intercalary arch gives to the tumid portion of the glabella a subcircular contour. The greatest number of eyelets in a vertical row appears to be six.

The presence of the genal spines separates this species from *Phacops* proper, but through the scantiness of our material we are not prepared to enunciate a more definite opinion at present.

Loc. and Horizon.—Mansfield District, Victoria—? Upper Silurian. *Coll.*—G. Sweet, Melbourne.

Genus HAUSMANNIA, Hall and Clarke, 1888.

Dalmania, Emmrich (*non* Desvoidey, 1830),* *Jahrb. für Min.*, 1845, p. 38.

Odontochile, Corda (*non* Laporte, 1834),† *Prod. Mon. Böh. Trilobiten*, 1847, p. 92.

Phacops (*Dalmania*), Salter, *Dec. Geol. Survey U.K.*, 1849, ii. p. 1.

Dalmania, Barrande, *Syst. Sil. Bohême*, 1852, I. p. 528.

Dalmanites, Barrande, *Loc. cit.*, p. 918, and *Expl. Plates, Atlas i.*

Dalmanites, Barrande, *Loc. cit.*, 1872, *Suppl. Vol. i.* p. 27.

Phacops (*Odontochile*), Salter, *Mon. Brit. Trilobites*, 1864, Pt. 1, p. 15.

Dalmanites, Hall, 11th *Ann. Rep. Geol. Survey Indiana*, 1881, p. 329.

Dalmanites (*Hausmannia*), Hall and Clarke, *Pal. N. York*, 1888, vii. pp. xxix and xxxi.

Obs.—In separating the old genus *Phacops* into convenient sections for systematic description the late Mr. J. W. Salter adopted the name *Odontochile*, Corda, for that group typified by *Phacops caudatus*, Emm., but for which the term *Dalmania* has otherwise almost universally been used. The latter name, proposed by Emmrich in 1845, had, however, been previously used by Robineau-Desvoidey for a genus of Diptera, and therefore became invalidated as a generic name for Trilobites. Unfortunately also *Odontochile*, proposed by Corda in 1847, was inapplicable from the fact that it was made use of in 1834 by Laporte to represent a genus of Coleoptera.

* *Dalmania*, Desvoidey, 1830, a genus of Diptera.

† *Odontochile*, Laporte, 1834, a genus of Coleoptera.

The previous use of *Dalmania* seems to have escaped the notice of Barrande, for we find him using the name throughout the first volume of his magnificent work on the Bohemian Silurian System, until nearly the close of the volume, when for a single species in the Addenda, the word *Dalmanites* is employed, and continues throughout the atlas. It is therefore possible that in the interval Barrande discovered the inutility of the name *Dalmania*, and by the use of the termination *ites* sought to discriminate between *Dalmania*, Emmrich, and *Dalmanites*, Barrande. At the same time an objection has been raised by some authors that even *Dalmanites* is not sufficiently distinctive.

Prof. James Hall, in one of his numerous critical contributions to American Palæontology, seems inclined to advocate the claims of *Odontocephalus*, Conrad, 1840 (= *Cryphæus*, Green, 1837, *non Cryphæus*, Klug, 1833, a genus of Coleoptera; and *Pleuracanthus*, M. Edw., 1840, *non Pleuracanthus*, Ag., 1837, an Ichthyodorulite). If, however, *Odontocephalus* is restricted to forms resembling its type species, *Asaphus selenurus*, Eaton (= *Calymene odontocephala*, Green), in which the anterior border of the cephalon is denticulated or fimbriated, a good generic distinction, it cannot possibly clash with *Dalmanites*. Indeed, we imagine this had already struck Prof. Hall, for in the seventh Vol. of the Palæontology of New York, by himself and Mr. J. M. Clarke, we find both names acknowledged much on the lines now explained. *Pleuracanthus* might have been adopted had not Agassiz in 1837 made use of the term for an Ichthyodorulite.

Unless we have overlooked any step in the discrimination of this generic type, and that is not impossible, there remain two courses open to us—either to adopt *Dalmanites*, following Barrande, or to propose a new genus. We are loth to adopt the latter alternative, more especially as Hall and Clarke have proposed as a subgenus under *Dalmanites* the name *Hausmannia*, with practically the same characters as the genus proper. They remark, “It is here proposed to group under the type *Hausmannia* the typical and unvaried forms of *Dalmanites*, which follow the

type of *D. caudatus* (Brünnich) Emmrich, and *D. Hausmanni*, Brongniart."

Under these circumstances, the adoption of *Hausmannia* in place of *Dalmanites* will surmount all difficulties in connection with the latter name. This suggestion is strengthened by the fact that Barrande's *Dalmanites*, as pointed out by Schmidt, included Trilobites not only of the type of *Asaphus caudatus*, but also all other Phacopidae which did not agree with *Phacops* as restricted by him, and are comprised by other writers in *Acaste* and *Chasmops*.

HAUSMANNIA MERIDIANUS, *sp. nov.*

(Pl. XXXVIII., figs. 1-8; Pl. XL., fig. 1.)

Phacops (*Odontochile*) *caudatus*, McCoy (*non* Brünnich), Prod.

Pal. Vict. Dec. iii. 1876, p. 13, t. 22, f. 1-7; t. 23, f. 7-10.

Sp. Char.—*Body*.—Oblong ovoid. *Head-shield or cephalon*.—Semicircular, finely granulated, moderately inflated, surrounded by a thickened limb marked off from the cheeks and glabella by a fairly conspicuous groove. Glabella large, subpyriform, with straight and oblique sides, separated from the cheeks by deep and wide axial furrows; frontal lobes very tumose, and together subelliptical in shape, and in some specimens overhanging the furrows very slightly; the remaining lobes are flat and small, second pair subtriangular, third and posterior pair oblong; frontal furrows wide, and moderately deep, joining the axial furrows just in front of the eye, crossing the glabella very obliquely and almost meeting, the basal and median pairs linear, deep, and slit-like (in casts), and not reaching the axial furrows; posterior corners of basal lobes sloping rapidly into the axial furrows; fixed cheeks small, genal lobe* inflated, sloping rapidly into the axial furrow, separated from the palpebral lobe by a distinct groove, which anteriorly passes into the axial groove, and posteriorly passes round and under the eye; free cheeks large,

* That portion of the fixed cheek between the palpebral lobe and the axial furrow.

continuous, conspicuously deflected laterally; genal angles produced into strong spines reaching to the sixth segment of the thorax; neck furrow distinct, particularly where it joins the axial furrows, continuing across the lateral lobes subfalcately with increasing distinctness and width; facial sutures anteriorly rather straight to the border, thence continuous, posterior portions from the hinder ends of the eyes passing out laterally and falcately, cutting the borders of the free cheeks in a line with the base of the eye. Eyes large, each has 32 to 40 or even more vertical rows of lenses with a normal number of eleven in each central row, and in odd cases twelve to fourteen, giving an aggregate of about 400 lenses in a single eye of some mature specimens; the lentiferous face forms a subsemicardiod curve, above sloping backward at an angle of about 40° , below bounded by a shallow groove, height diminishing more gradually posteriorly than anteriorly; lenses spherical, closely packed in the vertical rows, which are separated by distinct spaces or partitions.

Thorax.—About equal in length to the combined width of one pleural lobe, and the axis or about two-thirds of its total width, and greater than that of either the head or tail, suboblong or subfusiform; axis subfusiform, greatest width at fourth or fifth segment, where it is slightly greater than the width of the neck ring; arched most prominently posteriorly, rather flat anteriorly; segments thickened at their bases, moderately arched; some axes show faint trilobation caused by feeble depressions traversing their length, these depressions are accentuated by rows of tubercles, one on each side, about midway between the central line and the axial groove; pleuræ one and one-third times as wide as the thorax, and between the axial grooves and fulcra rather horizontal, outer ends moderately deflected and recurved, the latter feature becoming more pronounced posteriorly; pleural grooves wide and shallow, beginning at the angles of junction with the axial grooves and passing out posteriorly at the bases of the claw-like ends, thus traversing the pleuræ diagonally, anterior ridges much stronger than the posterior, and passing across to the posterior edges at about midway

between the fulcra and outer ends, obliterating the pleural grooves as above stated, outer ends flattened and claw-shaped, the latter feature very distinct on the posterior pleuræ; sutures very distinct; evidences of granulation very small; axial grooves moderately distinct.

Pygidium.—Distinctly triangular, proportion of width to length (leaving out the terminal spine) is about as three to two, moderately arched; axis very distinct, a few of the anterior segments arched forward centrally, and in decorticated specimens the same segments are provided with sub-triangular articular spaces; normal number of rings in fully developed specimens is sixteen to eighteen, and even attaining nineteen exclusive of the terminal appendage, no distinct traces of tubercles observed, sides straight, tapering gradually and in perfect specimens being inseparable from the produced spine, which is of varying length in different individuals; outer ends of the anterior segments bear large nodes bounded on their inner sides by slight depressions similar to those referred to on the thoracic segments; in some cases posteriorly depressed between the side lobes; axial grooves distinct, anchylosing margins of the side lobes straight between the fulcra, ends sharply recurved; in their inflation and deflection agree with the lobes of the thorax, but in some cases the slope is gradual from the axial grooves; eleven pleuræ, each succeeding one having a greater backward curve until the last is nearly parallel with the axis; pleural grooves wide and shallow; anterior ridges very distinct, thickening at the inner edge of the limb, and thence vanishing towards the outer edge, and forming a tuberculous ridge along the inner edge of the limb; sutures distinct; limb wide, its inner edge distinctly marked by a suture; to this limb the tail spine is attached.

Obs.—The rows containing the maximum number of lenses are alternately one lens higher and lower top and bottom than the preceding row, while the succeeding rows on each side are level top and bottom, and in this manner each of these rows fore and aft of the central portion loses a lens until the corner rows have the minimum of two to three lenses. The maximum of eleven

lenses in a vertical row appears to be normal for the examples from the Middle Trilobite Bed; but a specimen from the Upper Trilobite Bed has thirteen to fourteen lenses in the central rows. The tail spine is anchylosed to the border, and when the border and spine are removed a short dagger-like extension of the axis is exposed, such as is shown in most of the figures of the European *H. caudatus*. It is in this condition that the tail of our species bears a strong resemblance to *H. caudatus*; but whatever may be the case in the latter, it is, judging from the evidence furnished by a large number of specimens, almost certain that, in every instance where the tail of our species exhibits the short deltoid form of spine, the true spine has suffered removal.

We believe the forms figured by McCoy from the Victorian Upper Silurian as *Phacops (Odontochile) caudatus* to be the same as our *H. meridianus*. His figures show the much longer eye and multisegmented pygidial axis; but McCoy's glabellæ are granulate. *H. meridianus*, both as regards the N.S. Wales and Victorian specimens is so finely granulate throughout as to be practically smooth without a lens.

Touching the relation of our species to the typical European *H. caudatus*, Brün., the eyes are proportionately further forward in *H. meridianus*, the palpebral lobes and genal lobes wider transversely, and there is no neck tubercle. The eyes are less lunate, or arched in contour, and consequently longer fore and aft, and the surface of the glabella non-tuberculate. The pygidia differ in the excess of segments over those of *H. caudatus*, possessing seldom less than sixteen in the axis of the smaller pygidia, and usually eighteen or nineteen exclusive of the terminal appendage. Victorian and N.S. Wales specimens agree in this. Our form is also long tail-spined when perfect, thus resembling *H. longicaudatus*, but unlike the latter we have never seen an individual bearing a frontal spine. As regards the form of the glabella, *H. meridianus* seems to come nearer to *H. longicaudatus*. The genal spines are the same length in both the European and Australian forms. *H. caudatus* occasionally has a granulated pygidium axis,

but our species never has. Such granules are not to be confounded with the tubercular nodes at the outer ends of the segments.

H. meridianus vies in size with the large *H. Angelini*, Barr., from Étage D. of the Bohemian classification, and *H. rugosa*, Corda, but both of these are sub-mucronate in front, and possess much longer genal spines, and other points of departure.

It unquestionably falls into Hall and Clarke's section *Hausmannia*,* suggested by these authors for the "typical and unvaried forms of *Dalmanites*, which follow the type of *D. caudatus* (Brünnich) Emmrich, and *D. Hausmanni*, Brong." As, however, *D. caudatus* was selected by Barrande as the type of his genus *Dalmanites*, it follows that Hall and Clarke's term must be synonymous with the latter, a point that it is strange did not strike these eminent writers. At the same time we have here a solution of the generic difficulty, for if by common consent the name *Dalmanites* is not to stand, that proposed by the American Palæontologists will take its place.

The large increase in the number of pygidium segments in the Australian Trilobite is not peculiar to that species. *H. auriculata*, Barr., has twenty-three axial rings, *H. Hausmanni*, Brong.,† possesses eighteen, and several American species are found to have an increased number over that seen in the typical *H. caudatus*.

Loc. and Horizon.—Bowning, Co. Harden, Upper and Middle Trilobite Beds; Hatton's Corner, near Yass; Limestone Creek, near Bowning, Co. Harden—Bowning or Hume Series—? Wenlock. *Coll.*—Mitchell; Mining and Geol. Museum, Dept. Mines, Sydney; Australian Museum, Sydney.

D. meridianus is another of the most persistent of our Upper Silurian forms, being met with near the base, and also at the close of the Bowning Series.

* Pal. N. York, 1888, vii. p. xxxi.

† Burmeister, Organization of Trilobites (*Ray Soc.*), 1846, t. 5, f. 10.

In Victoria it is found in the olive mudstones of Broadhurst's Creek, near Kilmore, and in the arenaceous beds of Yerring, Upper Yarra.

In Tasmania the species occurs in the Despatch Limestone of Zeehan and Heazlewood, N.W. Tasmania.

EXPLANATION OF PLATES.

Plate XXXVIII.

HAUSMANNIA MERIDIANUS, *E. and M.*

- Fig. 1.—An almost entire specimen; Bowning. *Coll. Mitchell.*
 Fig. 2.—Pygidium showing the increased number of segments, absence of test on the limb, and the acicular spine; Bowning. *Coll. Mining and Geol. Museum.*
 Fig. 3.—Pygidium of a young individual with a well-developed acicular spine; Bowning. *Coll. Ibid.*
 Fig. 4.—Glabella, portion of fixed cheeks, and one eye. Frontal lobe elliptical and strong eye lobes; Bowning. *Coll. Mitchell.*
 Fig. 5.—Portion of cephalic shield showing the right facial suture and form of the eye lobe; Bowning. *Coll. Mitchell.*
 Fig. 6.—An eye and palpebral lobe, $\times 3$. *Coll. Mitchell.*
 Fig. 7.—Free cheek showing course of posterior portion of left facial suture, and the genal spine; Bowning. *Coll. Mitchell.*
 Fig. 8.—Hypostome. *Coll. Mitchell.*

PHACOPS SWEETI, *E. and M.*

- Fig. 9.—Partially rolled specimen, with thorax and pygidium; Mansfield District, Vict. *Coll. Sweet.*

Plate XXXIX.

PHACOPS SWEETI, *E. and M.*

- Fig. 1.—Cephalic shield somewhat distorted by pressure, but with the left eye intact; Mansfield District, Vict. *Coll. Sweet.*
 Fig. 2.—Decorticated cephalic shield showing the quadrate contour of the cephalic shield, small basal lobes, intercalary nodules, neck ring, and eyes; Mansfield District, Vict. *Coll. Sweet.*

PHACOPS LATIGENALIS, *E. and M.*

- Fig. 3.—Cephalic shield slightly distorted; Bowning. *Coll. Mitchell.*
 Fig. 4.—Portion of another cephalic shield slightly distorted, showing glabella furrows and rounded genal angle; Bowning. *Coll. Mining and Geol. Museum.*
 Fig. 5.—Another cephalic shield, showing the deep glabella furrows and axial grooves, tumid glabella, wide frontal lobe, and left intercalary nodule; Bowning. *Coll. Mitchell.*
 Fig. 6.—Front and under view of cephalon, showing (a) rudimentary limb, (b) linear ridge and (c) roof of mouth; Bowning. *Coll. Mitchell.*

PHACOPS SERRATUS, *Foerste.*

- Fig. 7.—Portion of the glabella and thorax; Bowning. *Coll. Mitchell.*
 Fig. 8.—Thorax, side view, showing the bluntly spined median line of the segments; Bowning. *Coll. Mitchell.*

PHACOPS CROSSLEII, *E. and M.*

- Fig. 9.—Thorax and pygidium; Bowning. *Coll. Mitchell.*
 Fig. 10.—Cephalic shield, with the furrows, eyes, neck ring, intercalary nodules, and rounded genal angles; Bowning. *Coll. Mitchell.*
 Fig. 11.—Cephalic shield and portion of thorax; Bowning. *Coll. Mitchell.*

PHACOPS MANSFIELDENSIS, *E. and M.*

- Fig. 12.—Portion of a cephalic shield showing a very tumid and subpentagonal glabella, and a strong intercalary furrow, $\times 2$; Mansfield District, Vict. *Coll. Sweet.*

Plate XL.

HAUSMANNIA MERIDIANUS, *E and M.*

- Fig. 1.—Portion of head shield; Kilmore, Vict. *Coll. Mining and Geol. Museum.*

PHACOPS LATIGENALIS, *E. and M.*

- Fig. 2.—Large cephalic shield distorted, showing the tumid glabella and coarse granulation; Bowning. *Coll. Mitchell.*
 Fig. 3.—Portion of a pygidium; Bowning. *Coll. Mining and Geol. Museum.*
 Fig. 4.—Another pygidium of large dimensions, believed to be that of this species; Bowning. *Coll. Mitchell.*
 Fig. 5.—Portion of head and thorax; Bowning. *Coll. Mitchell.*

Fig. 6.—Young specimen—portion of cephalic shield, with linear glabella furrows; Bowning. *Coll. Mitchell.*

PHACOPS SERRATUS, *Foerste.*

Fig. 7.—Portion of cephalic shield; Bowning. *Coll. Mitchell.*

Fig. 8.—Portion of another cephalic shield, tumid glabella, and neck tubercle; Bowning. *Coll. Mitchell.*

PHACOPS LATIGENALIS, *E. and M.*

Fig. 9.—Rostral shield with the hypostome *in situ*; Bowning. *Coll. Mitchell.*

PHACOPS SWEETI, *E. and M.*

Fig. 10.—Central portion of an eye, $\times 2$; Mansfield District, Vict. *Coll. Sweet.*

PHACOPS SERRATUS, *Foerste.*

Fig. 11.—Side view of the cephalic shield, with the neck spine prominently shown.

All the figures, unless otherwise indicated, are of the natural size.